# EFFECTS OF WEATHER ON NOCTURNAL MIGRATION AS SEEN FROM ONE OBSERVATION POINT AT PHILADELPHIA

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Most bird students are aware that during migration many transient species can be observed in most of the small parks and "squares" scattered throughout the large eastern cities, but many of these places, however interesting, remain unstudied during migrations because of the more varied birding available outside cities. Yet, city oases afford an opportunity to study nocturnal migration in a manner which can not be accomplished in the country. Daytime observations in wooded areas can be misleading, for many night-flying species do a considerable amount of diurnal traveling through the tree tops. Such migrants, with but few exceptions, are rarely seen flying over treeless sections of large cities in the day. When they are first seen in the parks it is almost always at daybreak.

I have for the past several years kept a close vigilance over the small Botany Garden on the campus of the University of Pennsylvania in West Philadelphia. The small area of less than 500 × 500 feet, hemmed in by busy city, is a temporary haven for migrating birds. The place is particularly attractive to migrants because of the varied plantings of both deciduous and evergreen plants and the presence of a pond of approximately one thousand square feet.

When a night migrant comes to the garden, it can usually be discovered almost immediately and watched until it departs. The first appearance of a species in the garden does not necessarily mean first arrival of that species for the Philadelphia region. More often than otherwise, birds arrive in the garden a few days after the species has been reported in the suburbs. The important thing is that we can be reasonably certain that the garden bird was flying over the city in migration on the previous night. We are able to acquire direct evidence of nocturnal migration by training a telescope on the lunar disc, but such observations, as valuable as they may be, produce little data on the kinds (species) that are flying, and peak migrations do not always coincide with the full moon.

## Southbound Migration

Southbound nocturnal migration has long been of special interest to me. Working on the premise just outlined, I have correlated autumnal flight with wind direction during the past three years. I found that birds are mostly on the wing on nights with light to moderate north or northwest winds. Since these conditions prevail just after a cold front passes toward the south or southeast over the eastern seaboard, major migrations throughout September

and October are readily predictable. A report of the fall migration of 1952, as seen from West Philadelphia, was published earlier (Devlin, 1953).

## Determination of Spring Migrants

In the spring of 1953, I made an effort to correlate northbound night migration with weather conditions. The Botany Garden was examined twice daily, once in the early morning and again in the evening, through 84 consecutive days from March 14 to June 5. I seldom found a new bird in the evening that was not seen on the first survey. Occasionally a flicker was seen flying over city rooftops in daylight, but, because of the timing of the surveys, I feel fairly certain that diurnal migration did not contribute to the counts of flickers reported here.

The second daily survey sometimes showed that some birds had left the garden. These were often birds of timid species and usually happened on balmy days when many people came into the garden. I believe that these birds were actually chased out of the garden in the daytime, so their departure was not considered migration. To avoid confusion migrants were recorded only on arrival.

Migrants were identified as such by the following criteria: 1. all first arrivals; 2. reappearance of a species after an absence; 3. increase in numbers of a species—the difference being counted migrants. Often (by sex, age, distinctive plumage, or peculiarities of song) an individual could be identified for the duration of its stay in the garden. When common species such as the Olive-backed Thrush, Red-eyed Towhee, or White-throated Sparrow were passing through in abundance it was not possible to determine migrants among them, and during such periods these species had to be ignored. Whenever I felt there was any doubt about a bird being a migrant, the bird was not recorded.

Daily meteorological notes were kept, and wind direction was found by releasing hydrogen-filled balloons. Special queries on local conditions were kindly answered by Mr. H. P. Adams of the Philadelphia Weather Bureau. Weather over the entire eastern United States was studied in retrospect from the daily government weather maps.

## Birds and the Wind

Soon after this study was started it became apparent to me that the hour just before nightfall was the *critical* time in nocturnal migration. If at that hour the winds were calm or southerly, migration could be expected. It did not seem to matter if the skies were overcast as long as it was not raining. Presumably, migrants took to the sky around dusk. Moon watching showed that when these conditions prevailed throughout the night, birds were in

flight all night and could be watched coming in from the sky soon after daybreak.

When unfavorable conditions for migration, such as heavy fog, rain, or cold north winds, occurred at Philadelphia and southward at the critical hour, there was no migration. If conditions became favorable (south wind, rising temperatures) during the night, there still was no migration. Seemingly, migrants do not often taken flight in the middle of the night.

There were times when weather conditions were unfavorable at Philadelphia but favorable over the region south of us at the critical hour. At such times birds in the south, apparently, were able to take flight, and, if conditions at Philadelphia changed to favorable during the night, the migration penetrated our region. On the basis of the above observations, we were able to predict migration with a high degree of accuracy. Predicting migration was as safe, at least, as forecasting the weather.

In 115 hours of careful searching, I identified 468 birds as nocturnal migrants. 310 of these arrived on southerly winds. 141 were in flight on so-called calm nights. Only 17 birds arrived on northerly winds, and it is interesting that these were early migrants, all of the family Fringillidae.

The word "southerly" as here used means that the entire air mass was moving from any point between east-southeast (clockwise around the compass) to west-southwest. There were 30 nights when the wind was southerly, and migration occurred on 25 of them. On five nights there was no migration; on four of these there were heavy rains throughout the whole region during the critical hour.

Theoretically, a calm night should be best for avian navigation. Nine nights were drawn as calms on the weather maps, and migration occurred on all nine of them. These were all personally investigated, and I found that in every case there was a "breeze" from the south 100 feet above the ground. A wind of 0.5 miles or less per hour is considered a calm. Absolute calms are rare, and if migrating birds should wait for them they might never reach the breeding grounds.

"Northerly" as used here means that the air mass was moving all night from any point between west-northwest (clockwise around the compass) to east-northeast. There were 32 such nights. Migration occurred on only two of them.

Winds were variable from west to northwest on three nights, and there was no evidence of migration.

On one night the winds were variable from east to southeast. Two migrants arrived.

Table 1 gives a list of migrants and the general direction of the winds which

bore them. Migration and weather from May 4 to May 14, inclusive, are presented pictorially in Figures 1 and 2.

TABLE 1

SPRING MIGRANTS AND THE WINDS WHICH BORE THEM

| *Species* | *Wind Direction* | | |
|---|---|---|---|
| | *Southerly* | *Calm* | *Northerly* |
| Yellow-billed Cuckoo. *Coccyzus americanus.* | | 2 | |
| Ruby-throated Hummingbird. *Archilochus colubris.* | 1 | | |
| Yellow-shafted Flicker. *Colaptes auratus.* | 10 | 7 | |
| Yellow-bellied Sapsucker. *Sphyrapicus varius.* | 3 | | |
| Downy Woodpecker. *Dendrocopos pubescens.* | 1 | | |
| Phoebe. *Sayornis phoebe.* | | 2 | |
| Crested Flycatcher. *Myiarchus crinitus.* | 3 | 3 | |
| Traill's Flycatcher. *Empidonax traillii* | 1 | | |
| Wood Pewee. *Contopus virens.* | 2 | 2 | |
| Brown Creeper. *Certhia familiaris.* | 8 | | |
| House Wren. *Troglodytes aëdon.* | 1 | | |
| Catbird. *Dumetella carolinensis.* | 15 | 7 | |
| Brown Thrasher. *Toxostoma rufum.* | 2 | 2 | |
| Wood Thrush. *Hylocichla mustelina.* | 1 | 3 | |
| Hermit Thrush. *Hylocichla guttata.* | 5 | 2 | |
| Olive-backed Thrush. *Hylocichla ustulata.* | 4 | 3 | |
| Gray-cheeked Thrush. *Hylocichla minima.* | 1 | | |
| Veery. *Hylocichla fuscescens.* | 2 | 1 | |
| Blue-gray Gnatcatcher. *Polioptila caerulea.* | 2 | | |
| Golden-crowned Kinglet. *Regulus satrapa.* | | 2 | |
| Ruby-crowned Kinglet. *Regulus calendula.* | 3 | 2 | |
| Yellow-throated Vireo. *Vireo flavifrons.* | 1 | | |
| Blue-headed Vireo. *Vireo solitarius.* | 1 | 1 | |
| Red-eyed Vireo. *Vireo olivaceus.* | 4 | 2 | |
| Black and White Warbler. *Mniotilta varia.* | 2 | 3 | |
| Blue-winged Warbler. *Vermivora pinus.* | | 1 | |
| Tennessee Warbler. *Vermivora peregrina.* | 1 | | |
| Parula Warbler. *Parula americana.* | | 3 | |
| Yellow Warbler. *Dendroica petechia.* | 2 | 1 | |
| Magnolia Warbler. *Dendroica magnolia.* | 6 | 3 | |
| Black-throated Blue Warbler. *Dendroica caerulescens.* | 1 | 5 | |
| Myrtle Warbler. *Dendroica coronata.* | 4 | 3 | |
| Black-throated Green Warbler. *Dendroica virens.* | 1 | 1 | |
| Chestnut-sided Warbler. *Dendroica pensylvanica.* | 3 | | |
| Bay-breasted Warbler. *Dendroica castanea.* | 2 | | |
| Black-poll Warbler. *Dendroica striata.* | 8 | 4 | |

TABLE 1 (Cont'd)

| | | | |
|---|---|---|---|
| Prairie Warbler. *Dendroica discolor* | 2 | | |
| Palm Warbler. *Dendroica palmarum.* | 1 | | |
| Oven-bird. *Seiurus aurocapillus.* | 4 | | |
| Northern Water-thrush. *Seiurus noveboracensis.* | 1 | | |
| Louisiana Water-thrush. *Seiurus motacilla.* | 1 | | |
| Yellow-throat. *Geothlypis trichas.* | 8 | 3 | |
| Yellow-breasted Chat. *Icteria virens.* | 1 | | |
| Hooded Warbler. *Wilsonia citrina.* | 1 | | |
| Wilson's Warbler. *Wilsonia pusilla.* | | 1 | |
| Canada Warbler. *Wilsonia canadensis.* | | 2 | |
| Redstart. *Setophaga ruticilla.* | 2 | 7 | |
| Baltimore Oriole. *Icterus galbula.* | | 2 | |
| Scarlet Tanager. *Piranga olivacea.* | 2 | 1 | |
| Rose-breasted Grosbeak. *Pheucticus ludovicianus.* | 1 | | |
| Indigo Bunting. *Passerina cyanea.* | 1 | 1 | |
| Purple Finch. *Carpodacus purpureus.* | 2 | | |
| Red-eyed Towhee. *Pipilo erythrophthalmus.* | 8 | 5 | |
| Slate-colored Junco. *Junco hyemalis.* | 86 | 14 | 4 |
| Chipping Sparrow. *Spizella passerina.* | 20 | | |
| Field Sparrow. *Spizella pusilla.* | 3 | 1 | 1 |
| White-throated Sparrow. *Zonotrichia albicollis.* | 59 | 36 | |
| Fox Sparrow. *Passerella iliaca.* | | | 2 |
| Song Sparrow. *Melospiza melodia.* | 6 | 3 | 10 |

## MIGRATION AND TEMPERATURES

Some attempt was made to find if there was any correlation between night flight and night temperatures. The problem becomes rather involved because we are dealing with variables such as vertical, linear, and time gradients in temperature. We must also *know* just how high the birds are flying. There still are not enough data, and to publish these would be premature. However, it appears that the Song Sparrow and the Golden-crowned Kinglet initiate nocturnal flight with air temperatures as low as 45°F. and may continue to fly even though the temperature may fall to almost freezing. Most birds probably prefer to fly in higher temperatures, and at Philadelphia after the first of April, winds from the south usually bring with them temperatures of 50°F. or higher. There is no doubt that low temperatures can be limiting, but in spring they seldom are, for southerly winds and mild weather go hand in hand.

South winds in late April sometimes do not bring as many migrants as might be expected. The explanation for this seems to be that by that time most of the early migrants have passed through and the long-distance migrants (mostly warblers) have not yet reached the Atlantic States. One thing

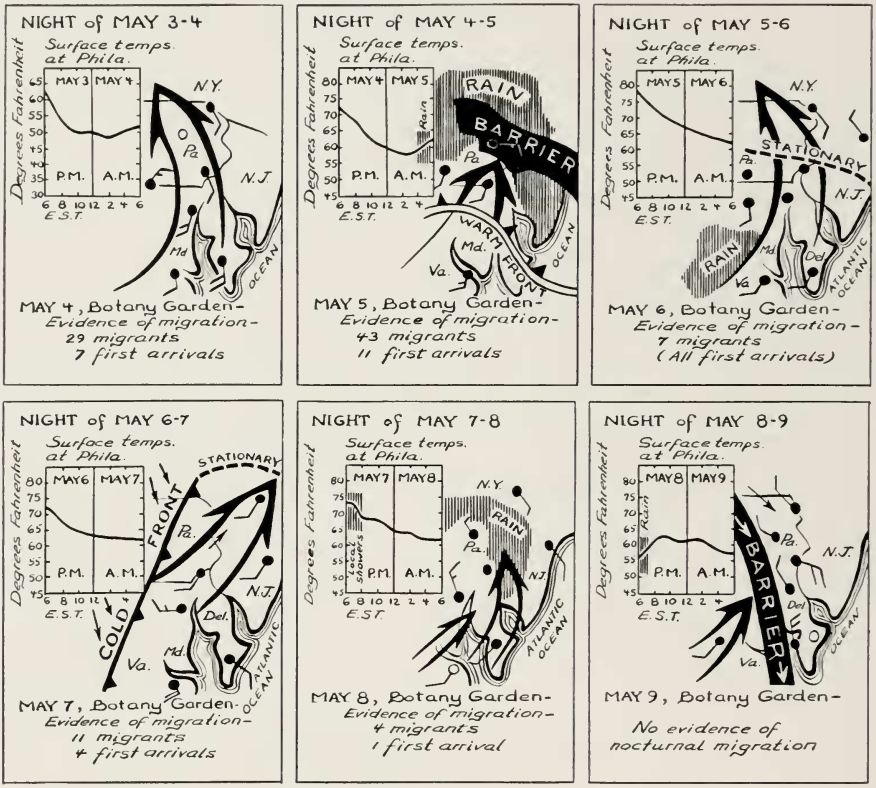


FIG. 1. Weather and nocturnal migration of birds at Philadelphia, May 3 through May 9, 1953. (Key to symbols in Fig. 2)

must be remembered—perfect weather for migration can not bring migrants if the birds have not yet acquired the urge to migrate.

Birding is commonly best during inclement weather, giving rise to the popular belief that birds migrate regardless of the weather. Usually, investigation shows that the birds began their flights before the weather turned unfavorable.

## LANDING AT NIGHT

Williams (1950) believes that migrants have difficulty in landing safely on dark nights. He concludes that, even though caught in a thunder storm, they are unwilling to land. This conclusion fits in well with the observations made at the Botany Garden.

On several occasions I was able to focus a telescope on the moon through a hiatus in the thunder clouds immediately after a violent storm. Birds were

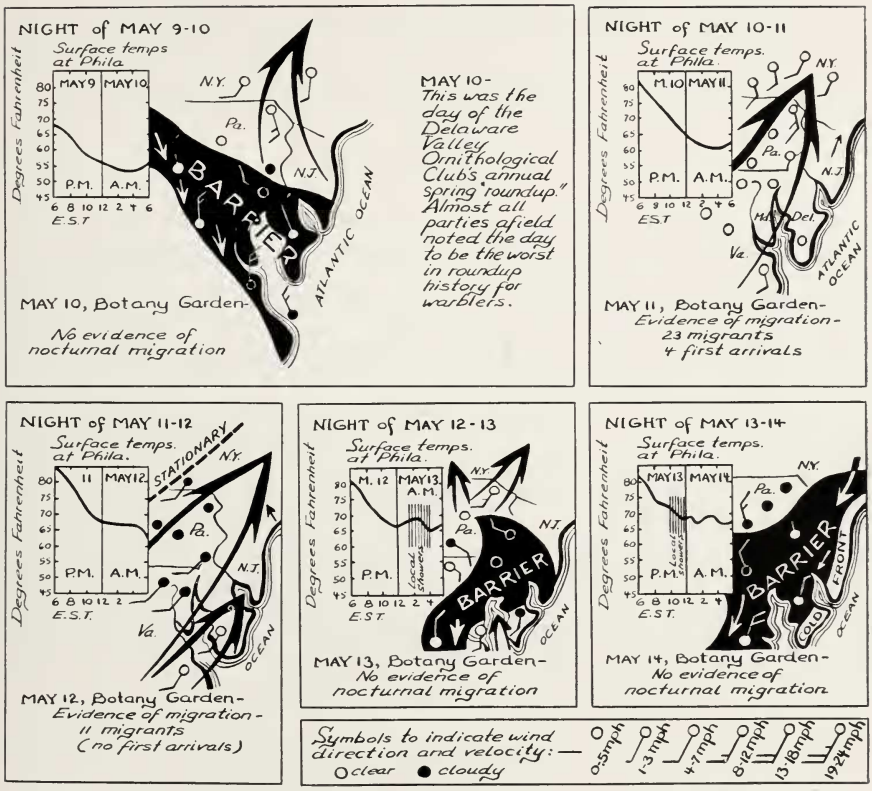


FIG. 2. Weather and nocturnal migration of birds at Philadelphia, May 10 through May 14, 1953.

still aloft. Whether or not they were flying above the storm I am not certain. Only once did I find a water-logged bird (Yellow-bellied Sapsucker) in the garden that I thought was forced to land at night.

In the evening of April 27, the wind was from the southwest and the telescope showed that migration was in full sway. A cold front bringing northwest winds passed through this area during the night, but telescopic observations indicated that the migrants continued to fly on the southerly wind high above the cold front slope. We watched the birds come in from the sky at dawn.

Essentially the same thing happened on the night of May 27-28, when again moon watching revealed that birds were aloft on southerly winds, when northerly winds prevailed at the surface.

In the fall, flying into adverse winds may end in catastrophe. Migrants on

a following wind meeting a warm front with strong southerly winds may be forced to fly very low *under* the frontal slope. Apparently that is what happened on the night of September 21-22, 1953, when 300 migrants crashed to death against the Empire State Building in New York City.

## Discussion

The idea that bird migrations proceed according to the weather is by no means new. Thus, the late Wells W. Cooke (1910) noted that in spring "birds prefer migrating in warm weather." However, the concept met with strong disfavor by many top-ranking ornithologists. Wetmore (1927) and others supposed that birds were driven by an irresistible migrational urge to arrive at the breeding grounds by the calendar.

Today the majority of workers believe that weather plays an important rôle in migration. The works of Lowery (1946), Williams (1950), and Imhof (1953) present convincing data which show some of the effects of weather on nocturnal bird flight.

Captain Neil T. McMillan (1938), of Eastern Air Lines, wrote "to a bird on the wing, the wind is a vehicle or means of transportation. It is the air that goes places and the birds go with it." According to Lincoln (1950) and others, the main objection to birds on the wind seems to be that the migrant becomes an object driven hither and thither, *unable to navigate.*

When a mass migration happens on an 18 miles per hour tail wind, it seems inconceivable that birds are guided across magnetic or coriolis fields, or that they can be following landmarks like mountain ranges, rivers, or coast lines. Newman (1952) wrote, "It looks as though migrants tend to travel with the wind toward low pressure areas." Studies at the Botany Garden indicate that night migrants travel with the wind regularly.

How do birds find their way? The most baffling of all questions about migration becomes even more baffling.

## Summary

By keeping a close watch for migrants in some small park in a large city one is able to determine the nights of migration. When it is known on what nights birds are in flight, the appropriate correlations with weather can be made. The writer has been interested in this sort of observational research and has used the Botany Garden on the campus of the University of Pennsylvania for the field work.

In the spring of 1953 it was found that the majority of migrants arrived on southerly winds or on temperate calm nights. Relatively few birds came in on nights with northerly winds.

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218 South 43rd St., Philadelphia 4, Pennsylvania, August 7, 1953

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## NEW LIFE MEMBER

Dale A. Zimmerman was born at Imlay City, Michigan, on June 7, 1928. From early childhood birds have been a major interest for him and his ornithological travels have taken him to many areas from Canada to southern Mexico. He is at present studying for the Ph.D. degree at the University of Michigan, from which he has already received B.S. and M.S. degrees. Although his interests in birds are varied, he has devoted much time to field studies of birds in Michigan and Mexico and to studies of avian distribution in general. Additionally, Zimmerman actively bands, paints, and photographs birds.